

## Claims

1. A regenerative braking power supply for a direct current traction motor comprising:

a converter including a plurality of controlled solid state switches having an input for receiving power from a power source and an output for providing controlled DC power for a traction motor;

a controllable freewheeling diode connected to the output of the converter; and

a braking controller for disabling the freewheeling diode for regenerative braking of the traction motor.

2. The regenerative braking power supply of claim 1 in which the power source is an AC power source, and the converter comprises a bridge rectifier.

3. The regenerative braking power supply of claim 1 in which the controllable freewheeling diode comprises an SCR having a gate connected to the braking controller.

4. The regenerative braking power supply of claim 2 in which the bridge rectifier comprises a three phase rectifier.

5. The regenerative braking power supply of claim 2 in which the controlled solid state switches comprise SCR's.

6. The regenerative braking power supply of claim 5 comprising a power controller connected to the controlled solid state switches.

7. The regenerative braking power supply of claim 1 in which disabling the freewheeling diode comprises placing the freewheeling diode in a non-conductive state.

8. The regenerative braking power supply of claim 3 in which disabling the freewheeling diode comprises turning the solid state switch off.

9. The regenerative braking power supply of claim 1 in which the power source is a DC power source and the converter comprises a DC/DC converter

10. The regenerative braking power supply of claim 9 comprising a power controller connected to the DC/DC converter.

11. The regenerative braking power supply of claim 9 in which the DC/DC converter comprises a controllable semiconductor switch connected in series with a DC power source, and a chopper controller connected to the controllable semiconductor switch.

12. The regenerative braking power supply of claim 11 in which the chopper controller and controllable semiconductor switch comprise a pulse width modulator.

13. The regenerative braking power supply of claim 11 in which the controllable semiconductor switch comprises an insulated gate bipolar transistor and the chopper controller is connected to a gate terminal of the transistor.

14. The regenerative braking power supply of claim 2 comprising a controllable semiconductor switch connected in series with the bridge rectifier, and a chopper controller connected to the controllable semiconductor switch.

15. The regenerative braking power supply of claim 14 in which the chopper controller and controllable semiconductor switch comprise a pulse width modulator.

16. The regenerative braking power supply of claim 15 in which the controllable semiconductor switch comprises an insulated gate bipolar transistor and the chopper controller is connected to a gate terminal of the transistor.

17. A transformerless dual DC traction motor controller comprising:  
a solid state power converter having an output;

a mode switcher for connecting two DC traction motors to the output in series in a first mode and connecting two DC traction motors to the output in circulating-current-free armature parallel configuration in a second mode.

18. The transformerless dual DC traction motor controller of claim 17 comprising a driver operable control connected to the mode switcher.

19. The transformerless dual DC traction motor controller of claim 17 comprising a slip sensor responsive to slippery conditions connected to the mode switcher.

20. The transformerless dual DC traction motor controller of claim 19 in which the slip sensor comprises a motor slip detector.

21. The transformerless dual DC traction motor controller of claim 17 in which the solid state power converter comprises an SCR phase angle controller.

22. The transformerless dual DC traction motor controller of claim 17 in which the solid state power converter comprises a DC/DC converter.

23. The transformerless dual DC traction motor controller of claim 17 comprising a freewheeling diode connected to the solid state power converter and in which the mode switcher comprises a solid state switcher reversibly connecting the armatures and the field windings of the DC traction motors in series to the output of the solid state power converter in the first mode, and connecting the field windings of the DC traction motors in series and the armatures of the DC traction motors in circulating current free parallel with each other, and in series with the field windings of the DC traction motors in the second mode.

24. The transformerless dual DC traction motor controller of claim 17 comprising a controllable freewheeling diode connected to the output of the solid state power converter; and

a braking controller for disabling the freewheeling diode for regenerative braking of the traction motor.

25. The transformerless dual DC traction motor controller of claim 24 in which the controllable freewheeling diode comprises a solid state switch comprising a gate connected to the braking controller.

26. The transformerless dual DC traction motor controller of claim 24 in which disabling the freewheeling diode comprises placing the freewheeling diode in a non-conductive state.

27. The transformerless dual DC traction motor controller of claim 26 in which the freewheeling diode comprises an SCR and disabling the freewheeling diode comprises turning the SCR off.

28. The transformerless dual DC traction motor controller of claim 23 comprising a switch connected between the armatures of the DC traction motors, the switch being closed in the first mode, and open in the second mode.

29. The transformerless dual DC traction motor controller of claim 23 in which the solid state switcher comprises a first plurality of controlled solid state switches connected to the first armature, and a second plurality of solid state switches connected to the second armature.

30. The transformerless dual DC traction motor controller of claim 17 comprising a current transducer connected to the DC traction motors to measure the current flow through the motors.

31. The transformerless dual DC traction motor controller of claim 17 comprising first and second voltage transducers connected to the DC traction motors for measuring the voltage applied to the motors.

32. The transformerless dual DC traction motor controller of claim 31 in which the voltage transducers are connected to armature windings of the DC traction motors.

33. The transformerless dual DC traction motor controller of claim 17 comprising an operator current controller; and

a control circuit responsive to the operator current controller and the current transducers connected to the solid state power converter for increasing the power of the power converter if the current sensed by the transducer falls below the current set by the operator current controller, and reducing the power from the power converter if the current sensed by the current transducer is greater than the current set by the operator current controller.

34. The transformerless dual DC traction motor controller of claim 29, in which the first plurality of controlled solid state switches comprises four solid state switches, and the second plurality of solid state switches comprises of four solid state switches.

35. The transformerless dual DC traction motor controller of claim 34 comprising a switch connected between the armature of the first DC traction motor in the armature of the second DC traction motor.

36. A method of controlling two DC traction motors each motor having an armature and a field winding including connecting the field windings of the two DC traction motors in series, connecting the armatures of the DC traction motors to the series connected field windings, and switching the armatures between a first series connected mode and a second circulating-current-free parallel mode.

37. The method of claim 36 comprising switching to the second mode in response to slippery conditions.

38. The method of claim 37 comprising manually switching to the second mode.

39. The method of claim 37 comprising automatically switching to the second mode in response to detecting slippery conditions.

40. The method of claim 39 comprising switching to the first mode in response to the absence of slippery conditions.

41. The method of claim 39 in which detecting slippery conditions comprises sensing motor slippage.

42. The method of claim 36 comprising regeneratively braking the DC traction motors.

43. The method of claim 36 comprising selectively regeneratively braking the DC traction motors.